THz acquisition and rendering with augmented reality

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NON-DESTRUCTIVE testing at terahertz frequencies has benefited in recent years from advances in semiconductor technologies (Si-based and III-V-based technologies), whose frequencies have been able to move from millimetric frequencies to terahertz. There are now commercially available terahertz radars. Applications of such non-destructive testing systems are for example composite materials inspection [1] or art painting diagnosis [2]. Moreover, even if some THz handled system were demonstrated [3-4], they do not allow a direct non-contact scan and we cannot see directly the image during the acquisition.

The experimental setup, illustrated on figure 1, combines an integrated wideband FMCW radar (122 GHz to 170 GHz), two 3" lenses with 115 mm focal length and a smartphone using a reality augmented interface. A metal plate (4x8cm) is placed below the painting at the mouth location. In this first demonstration, an intermediate processing step is performed between the radar and the smartphone using a computer. A Fourier transform and then the extraction of the amplitude corresponding to the position of the painting is sent to the smartphone as an analog voltage. After a first phase of calibration where we have to scan rapidly all the painting in order to generate a virtual mapping, we can move the system freely and see a THz image appearing on the phone screen with a color gradient which is superimposed on the painting (see Figure 2). It is necessary to stay in the Rayleigh zone (1cm) to have a homogeneous image. For this, a distance measurement based on camera image guide the experimenter during the acquisition, and an articulated arm can also be used to control the distance. A post measurement application allows then to see the results in augmented reality directly in the smartphone. This makes it possible to move, including with all the degrees of angular freedom, and to see the THz image either superimposed on the object, or by hovering a few centimeters from the object.

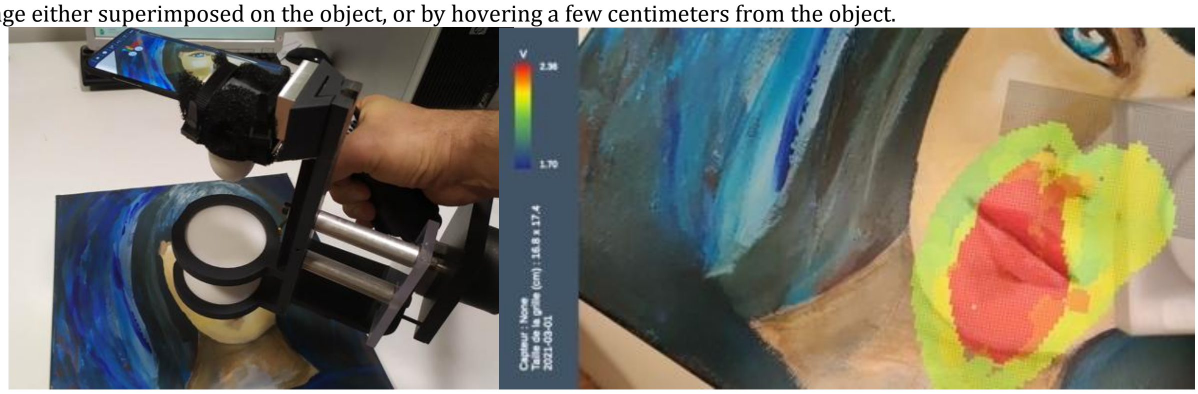

Figure 1 : (left) Photography of the experiment. A painting is manually scanned using the AR-THz system. (right) Screenshoot of the mobile application with a superimposition of the camera view and the THz image

The feasibility of AR-THz using FMCW imaging system is proven. A good match between the spatial resolution of the manual scan assisted by the smartphone and the resolution of the radar makes it possible to quickly obtain information on the analyzed object, with the possibility of seeing it in augmented reality. Radar signal processing in the computer is still a limitation at this time, but it could be integrated in the smartphone in the future, and for example thickness measurement or synthetic Aperture radar techniques.

References

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